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EECS 101: HW 2

1)

Coded CCD

3 electron standard deviation

$\frac{\text{Signal in electrons}}{\text{stand deviation of noise}}$

$N_{total} = N_A + N_p + N_{DC}$

$N_{DC} = \emptyset$

$\frac{S}{SD_N}$

$SD_N = 3 + SD_p + \emptyset$

$Var(N_p) = mean(S + N_{DC})$

$\frac{S}{mean(S + N_{DC}) + Var(N_A)}$

$\frac{S}{mean(S) + 3}$ = Signal to noise ratio

Amp, 3, 10%   90% of noise from N_p

27

$N_{total} = 30$

$N_A = 3$

$N_p = 27$

27 =

$Var(N_3) = mean(N_a^2) - (mean(N_A))^2$

$S2N = \frac{S}{N_{total}} = \boxed{47.7_e}$

$N_{total} = N_A + N_p + \emptyset$

$30 = 3 + 27 \rightarrow$

$Var(NP) = mean(S + 27)$

$Var(NP) = \frac{S+27}{2}$

$27^2 = \frac{S+27}{2}$

27 = std of NP

$\boxed{S = 1431_e}$

2)

2) $f_L = 8cm$

$D = 1cm$

10cm

$f = 8cm$

$d = 1cm$

$z' = 10cm$

$\frac{1}{z'} + \frac{1}{-z} = \frac{1}{f}$

a) Get an image with no blur

$\frac{b}{d} = \frac{|\bar{z}' - z'|}{\bar{z}'}$ $b = \emptyset$

$\frac{1}{10} + \frac{1}{-z} = \frac{1}{8}$

$\frac{1}{-z} = \frac{1}{8} - \frac{1}{10}$

$\emptyset = d\frac{|\bar{z} - 10|}{z}$ $\boxed{\bar{z} = 10cm}$

$\frac{1}{-z} = 0.025$

$-z = 40cm$

~~b) 3×3 500×500 9 how much the way~~ is how

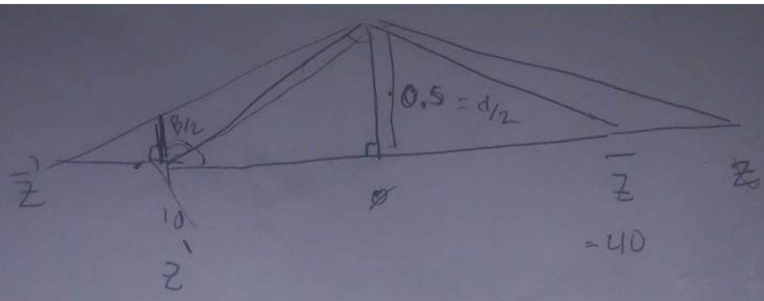
$\frac{1}{\bar{z}}$

$\frac{1}{z'} + \frac{1}{-z} = \frac{1}{f}$ $-z = 40cm$

$\bar{z}'$ $\frac{d}{z'}|\bar{z}' - z'|$

$-40 - 10$

$\frac{1}{z'} + \frac{1}{-z} = \frac{1}{f}$



$B = \emptyset$

$\frac{1}{z'} \left| \bar{z}' - z' \right|$

$A = 9\,cm^2$ / 500×500 pixels^2

$\emptyset = \frac{d}{z'} \left| \bar{z}' - z' \right|$

10 10

$\boxed{\bar{z}' = 10, \text{ that is where } B = \emptyset}$

b) when will Blur be larger than $3\times3 / 500\times500$ $9/25$~

$B = 0.000036\,cm$, area of a pixel

$\frac{0.000036\,cm}{1\,cm} = \frac{\left| \bar{z}' - 10 \right|}{10}$

$\boxed{10.00036\,cm > \bar{z}' > 9.99964\,cm}$

3)

A.

3. $N_{DC} = \phi$

- D is a pixel
- S = signal in electrons
- $N_A^2 = \sigma_A^2$
- $NP^2 = S$
- $N_Q = \sigma_Q^2$

$$D = (S + N_A + N_P)A + N_Q$$

$$Avg(D) = S \cdot A$$

$$\sigma_D^2 = A\mu + \sigma_C^2$$

$$\sigma_C^2 = A^2\sigma_A^2 + \sigma_Q^2$$

$$Var(N_P) = Mean(S + N_P)$$

$$2NP^2 = \frac{S+NP}{[illegible]}$$

$$2NP^2 - NP = S$$

$$SA = \sum_i (S + N_A + N_P)A + N_Q$$

$$E[\mu] = \mu = SA$$

$E[S] = S$

$E[A] = A$

$$E[S]E[A] = E[\mu]$$

$$\sigma_D^2 = A\mu + A^2\sigma_A^2 + \sigma_Q^2$$

$$A\mu + A^2 N_A^2 + N_Q^2$$

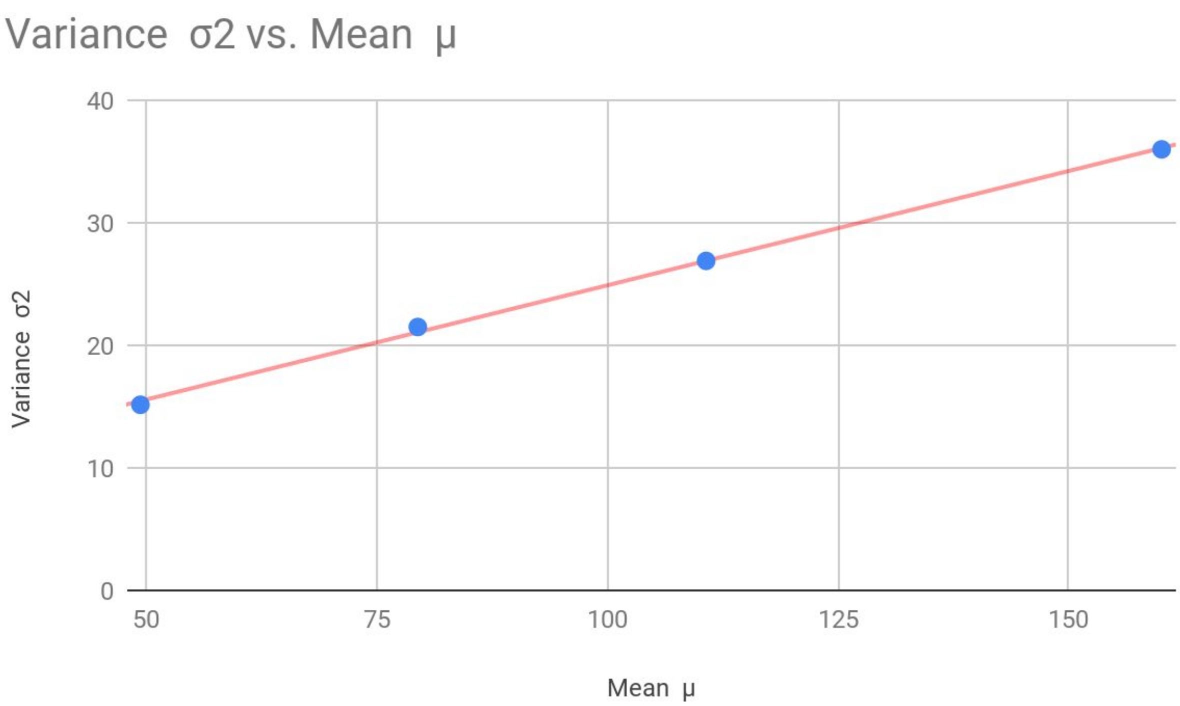
$$Var([illegible])^2 = A[\mu + A N_A^2] + N_Q^2$$

$$Var(\mu)$$

B. Code output

```
C:\Users\Bschnedar\Source\Repos\Project2\Debug\Project2.ex
image1.raw: Mean: 49.422600 Variance: 15.144367
image2.raw: Mean: 79.478500 Variance: 21.492956
image3.raw: Mean: 110.721100 Variance: 26.886707
image4.raw: Mean: 160.079193 Variance: 35.986778
Press any key to exit:
```

C.



A = sqr(mean) + std
O2c = var/(mean * amp)

image	A	O2c
1	53.27	0.0056
2	84.1	0.00321
3	115.18	0.00211
4	165.99	0.00135